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14. ABSTRACT

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Investigating the Strain Rate Effects on Cumulative Damage in a Highly Filled Polymeric Material

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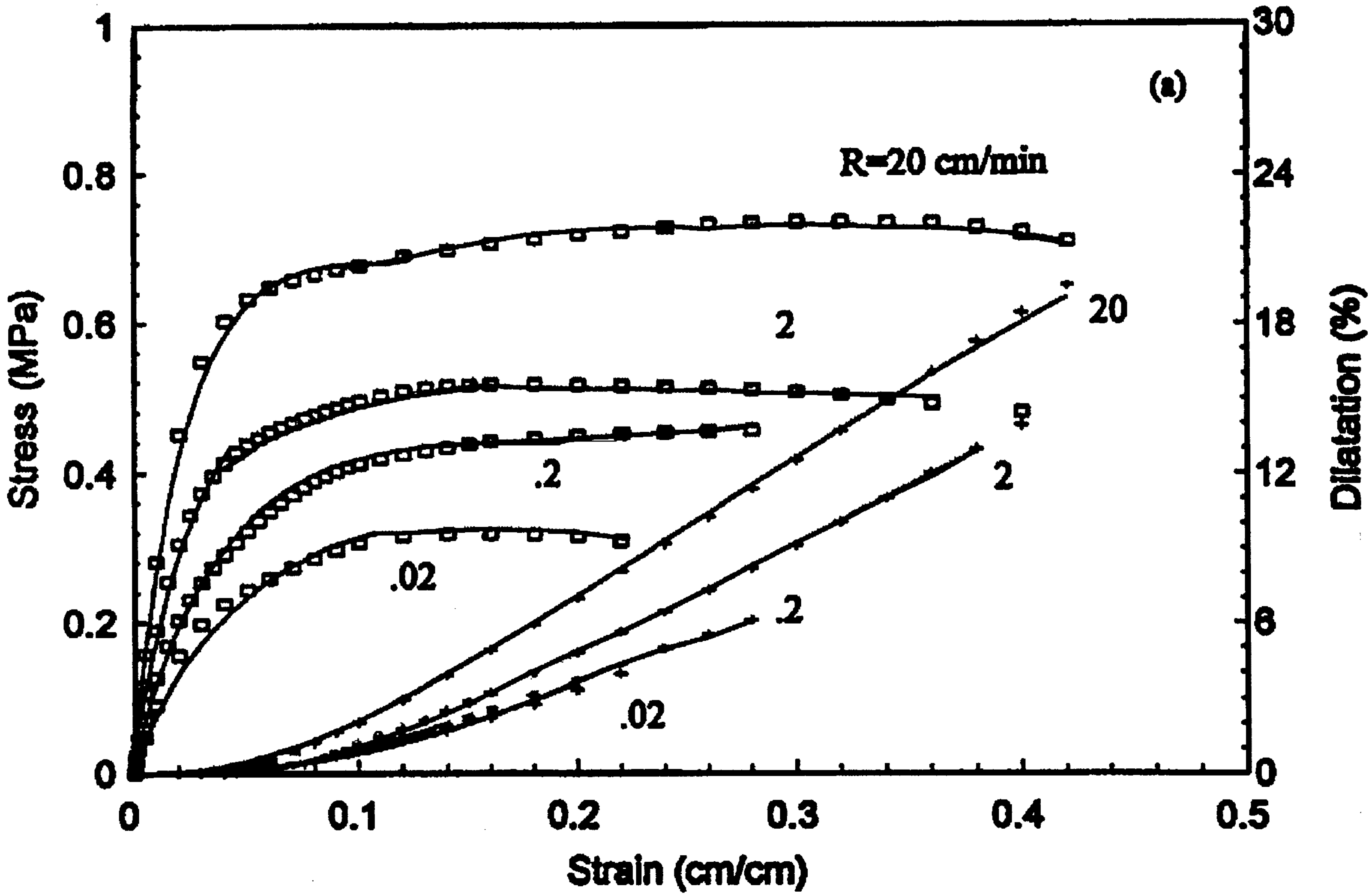
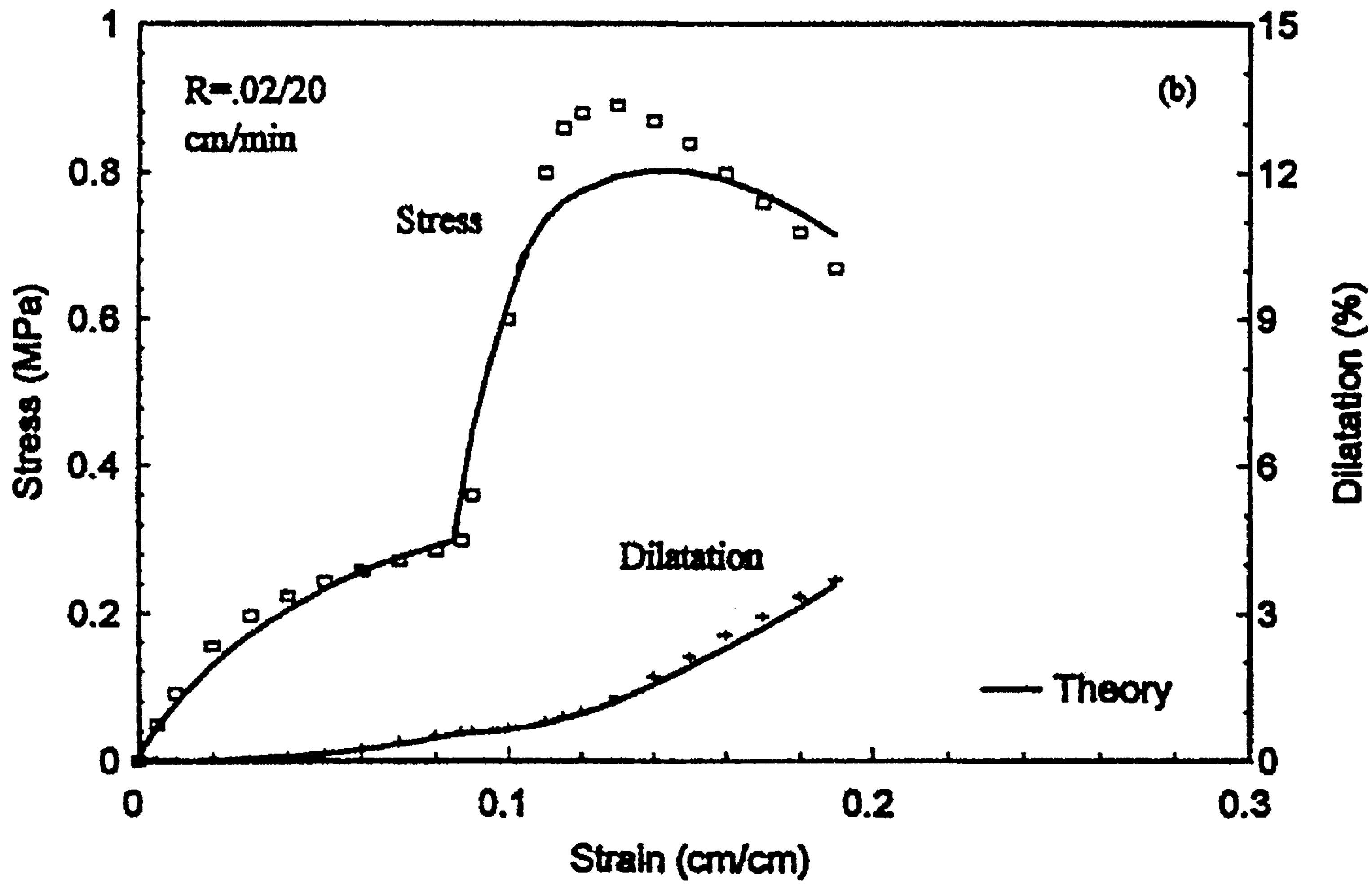
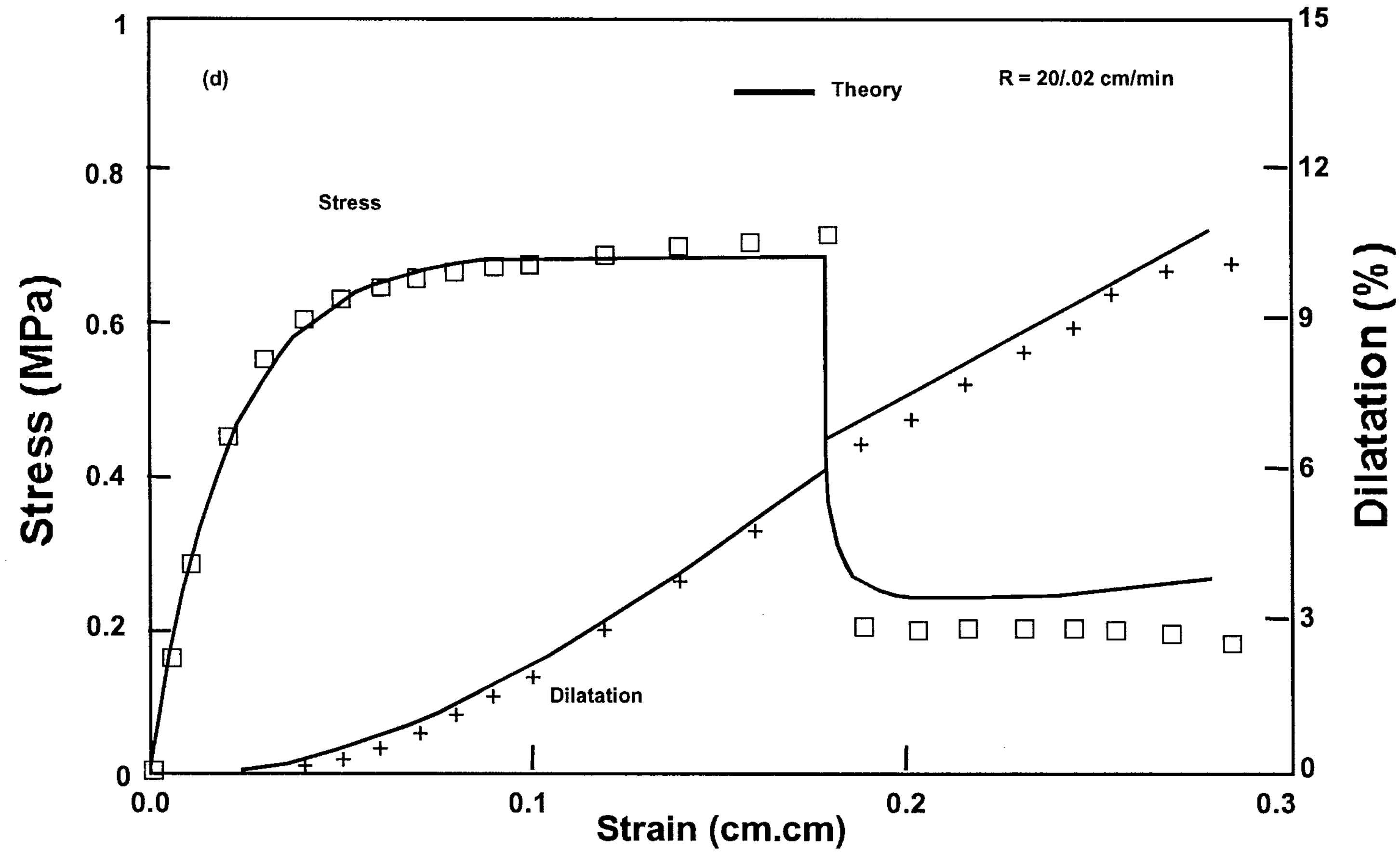
Objective:

- Investigate Cumulative Damage in a Highly Filled Polymeric Material under Constant and Dual-Displacement Rate Loading Conditions.
  - Constant Displacement Rates: 0.02, 0.2, 2, 20 cm/min
  - Dual-Displacement Rate:
    - 0.02 cm/min – 20 cm/min
    - 0.2 cm/min – 20 cm/min
    - 20 cm/min – 0.02 cm/min


(a)
R=20 cm/min
2
20
.2
2
.02
.2
.02
Stress (MPa)
Strain (cm/cm)
Dilatation (%)
0
0.2
0.4
0.6
0.8
1
0.1
0.3
0.5
6
12
18
24
30


R=.02/20
cm/min
(b)
Stress
Dilatation
— Theory
Stress (MPa)
Dilatation (%)
Strain (cm/cm)
1
0.8
0.6
0.4
0.2
0
15
12
9
6
3
0
0.1
0.2
0.3

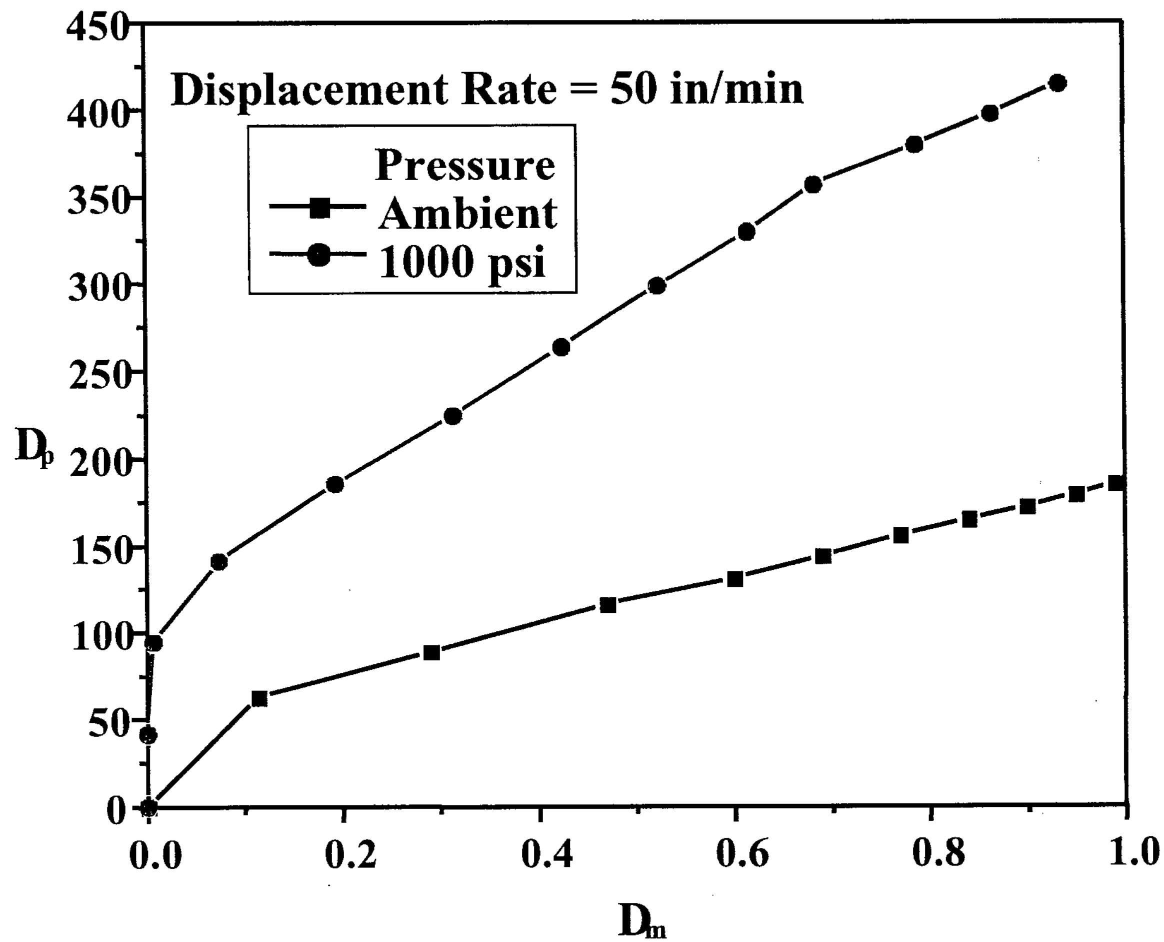

(d)
Theory
R = 20/.02 cm/min
Stress
Dilatation
Stress (MPa)
Dilatation (%)
Strain (cm.cm)
0
0.2
0.4
0.6
0.8
1
0.0
0.1
0.2
0.3
3
6
9
12
15

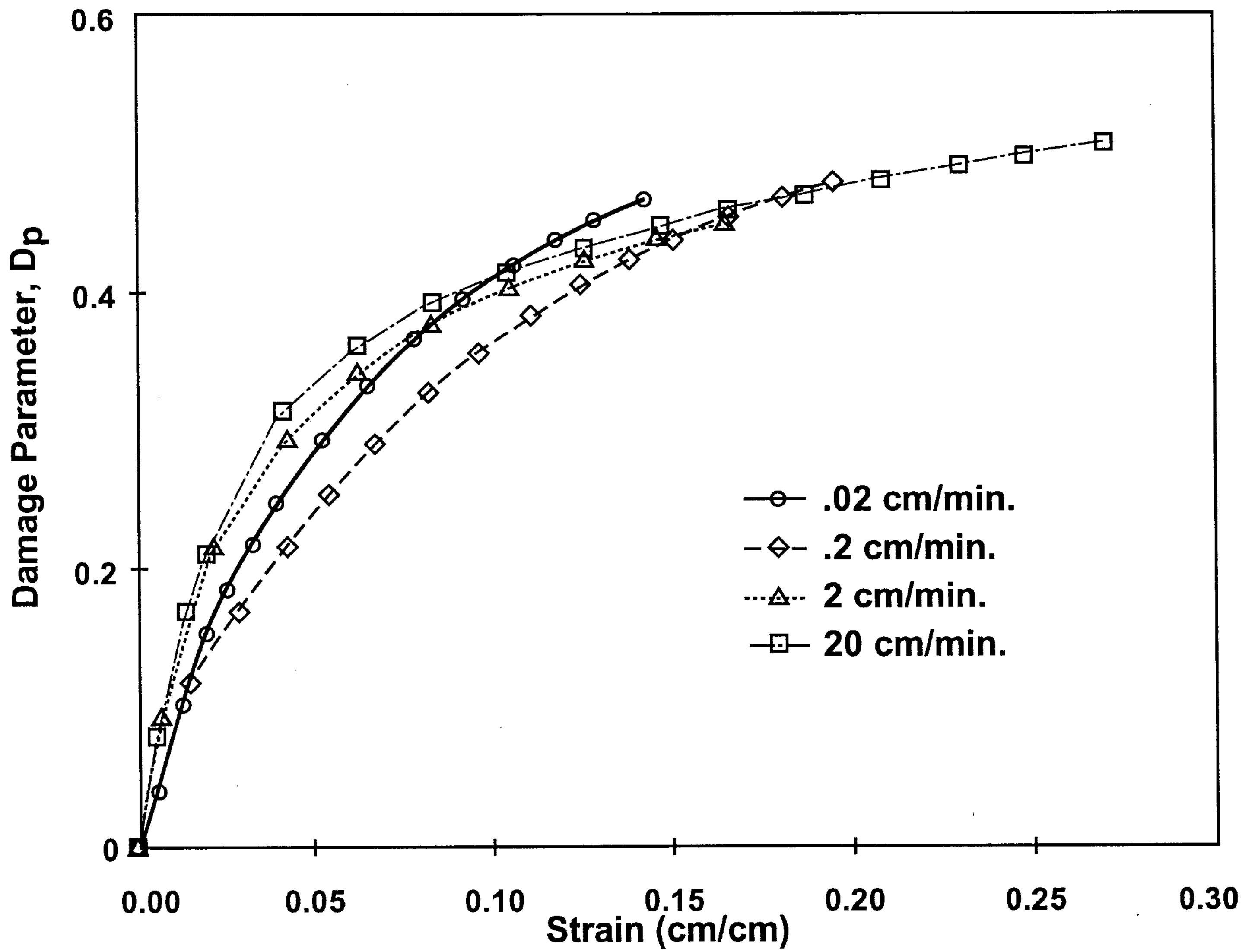
Phenomenological Damage Parameter Dp: $D(t)=\left[\int_0^t \sigma^{\beta}\, dt\right]^{1/\beta}$

Micromechanics Damage Parameter Dm

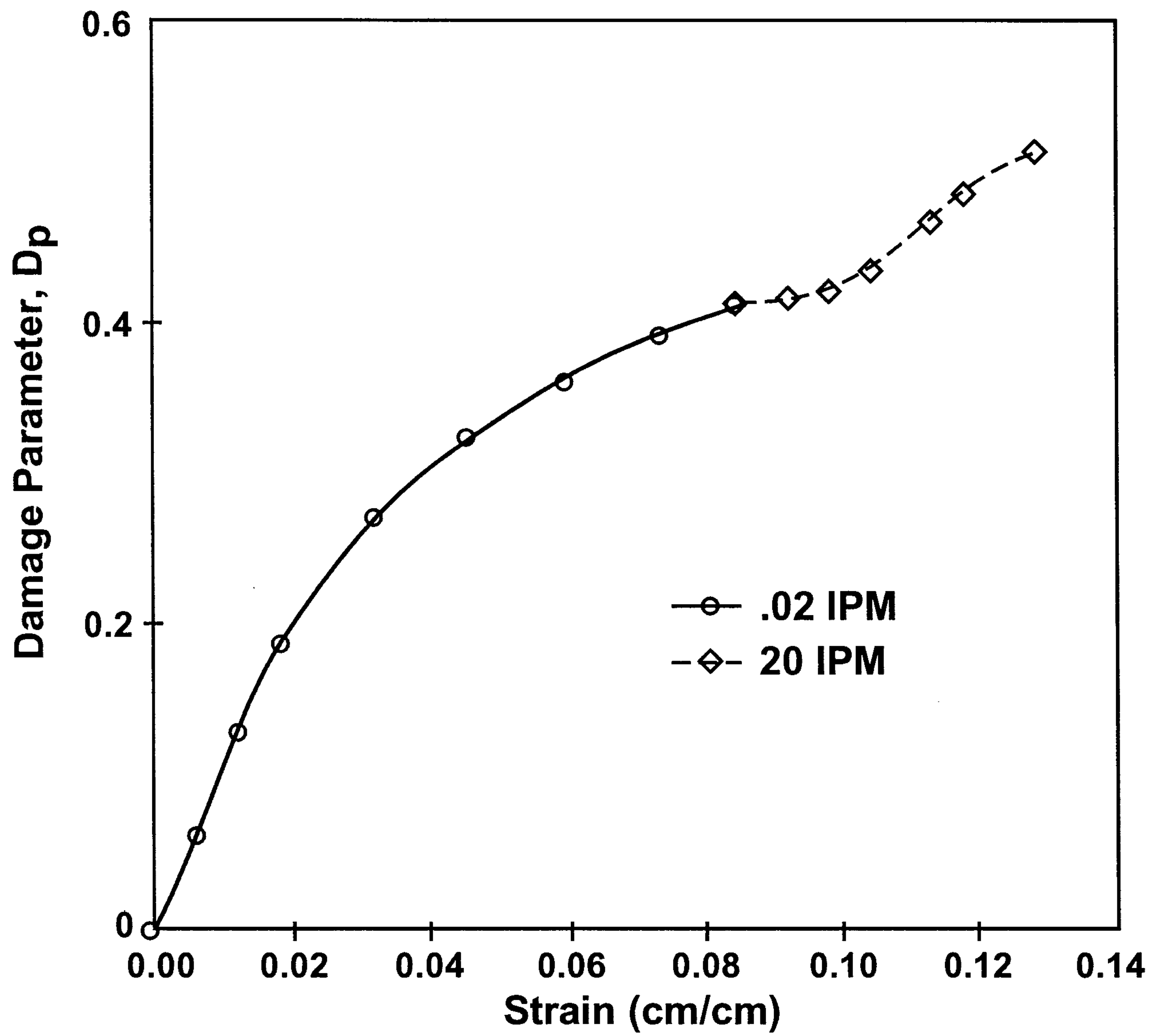
Damage Potential Function: F = f (ε_{ij}) -K

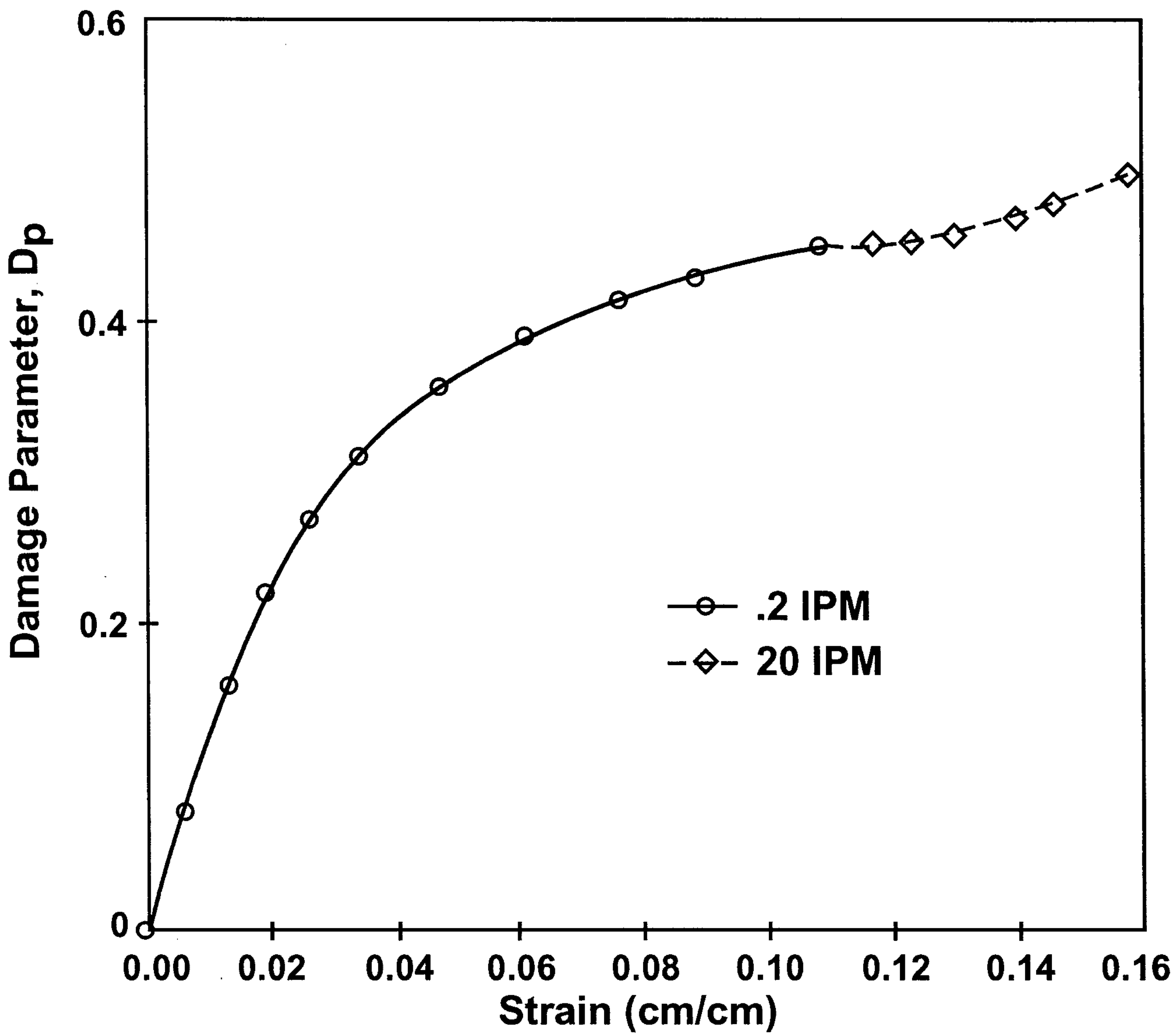
Damage Evolution Law: dDm/dt = [dK/dt] g (ε)

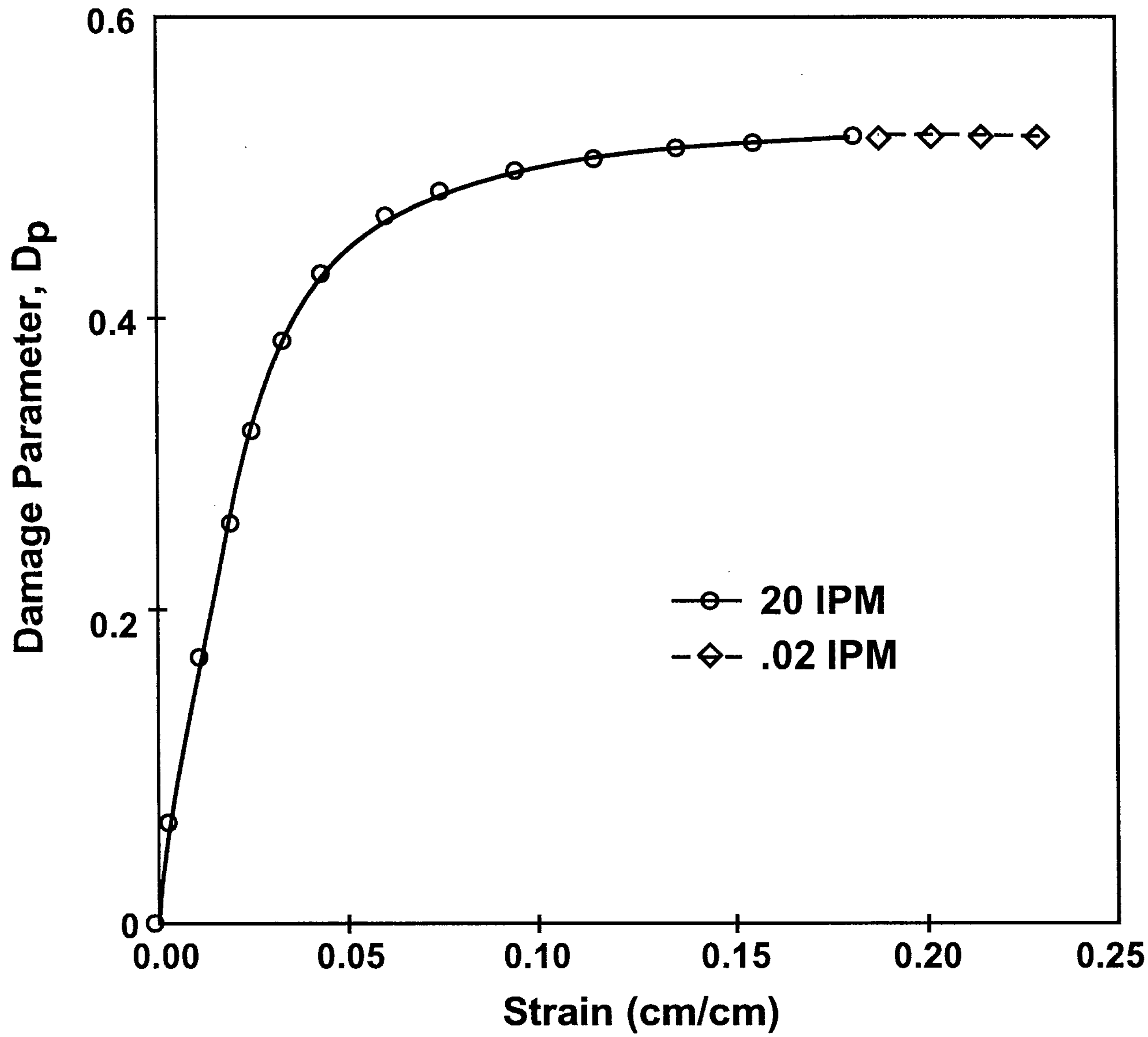


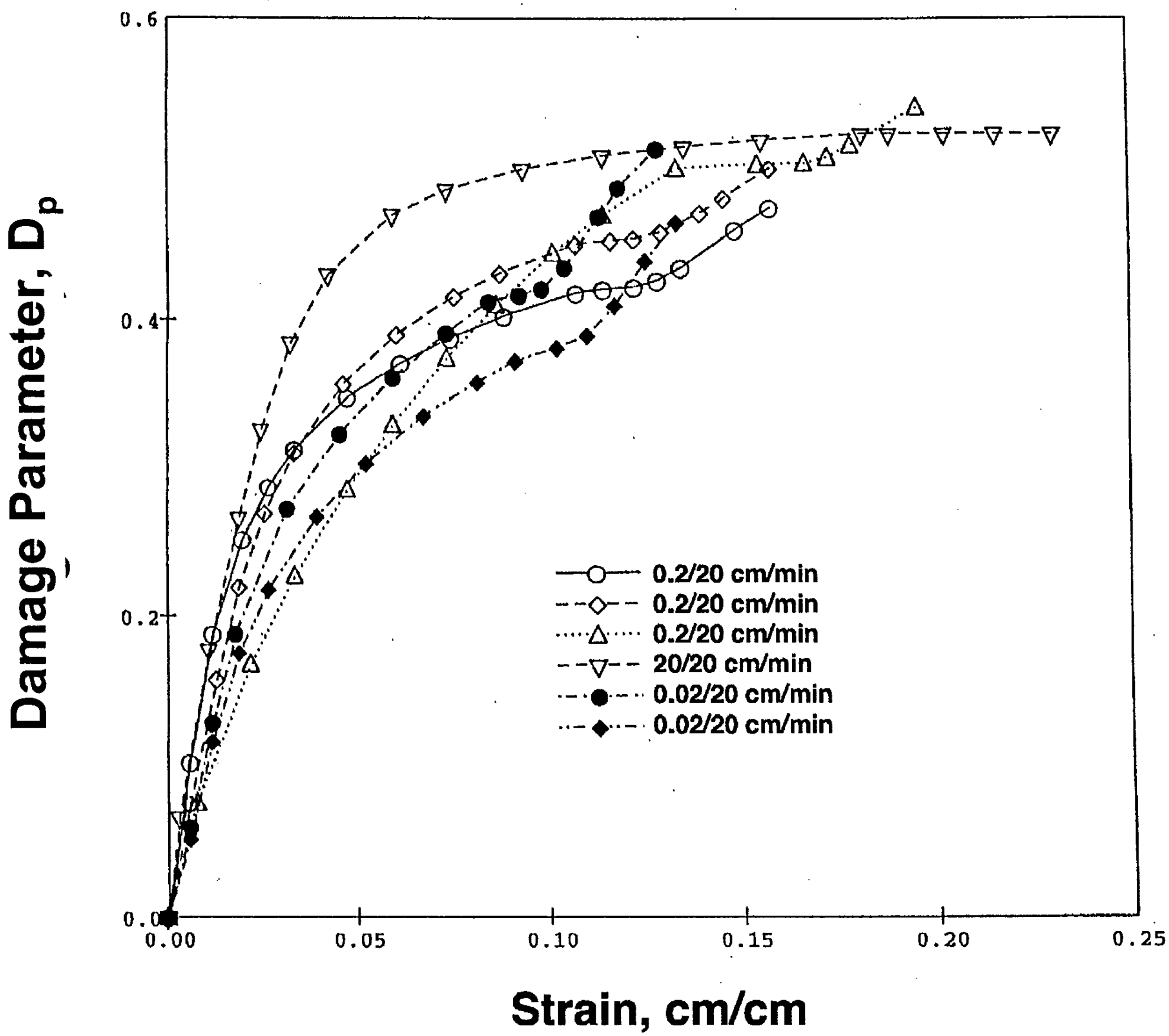


Damage Parameter, Dp
0.6
0.4
0.2
0
0.00
0.05
0.10
0.15
0.20
0.25
0.30
Strain (cm/cm)
.02 cm/min.
.2 cm/min.
2 cm/min.
20 cm/min.


0.6
0.4
0.2
0
Damage Parameter, Dp
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
Strain (cm/cm)
.02 IPM
20 IPM


Damage Parameter, D_p
0.6
0.4
0.2
0
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.16
Strain (cm/cm)
.2 IPM
20 IPM


0.6
0.4
0.2
0
Damage Parameter, D_p
0.00
0.05
0.10
0.15
0.20
0.25
Strain (cm/cm)
20 IPM
.02 IPM


0.6
0.4
0.2
0.0
0.00
0.05
0.10
0.15
0.20
0.25
Damage Parameter, D_p
Strain, cm/cm
0.2/20 cm/min
0.2/20 cm/min
0.2/20 cm/min
20/20 cm/min
0.02/20 cm/min
0.02/20 cm/min

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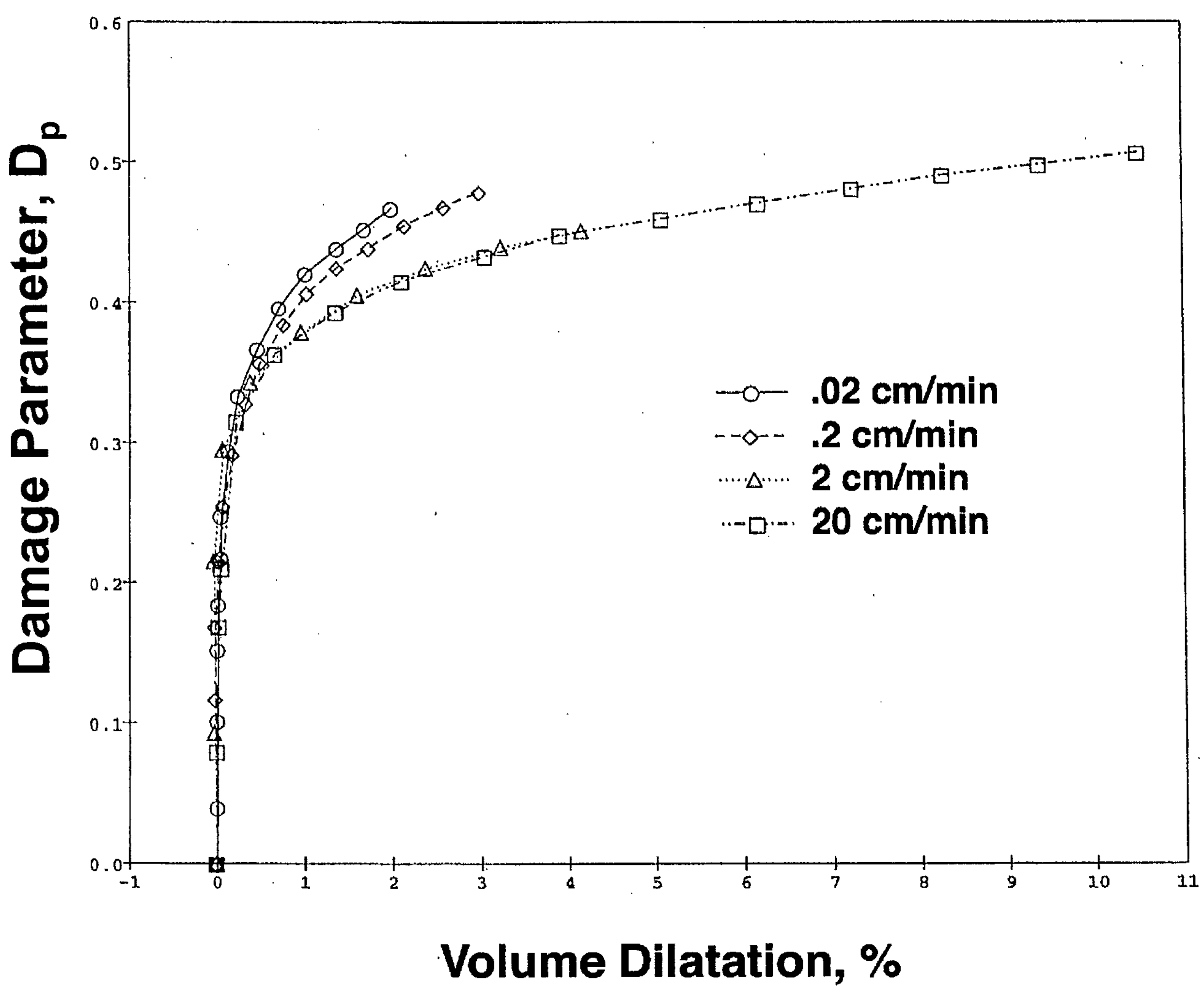

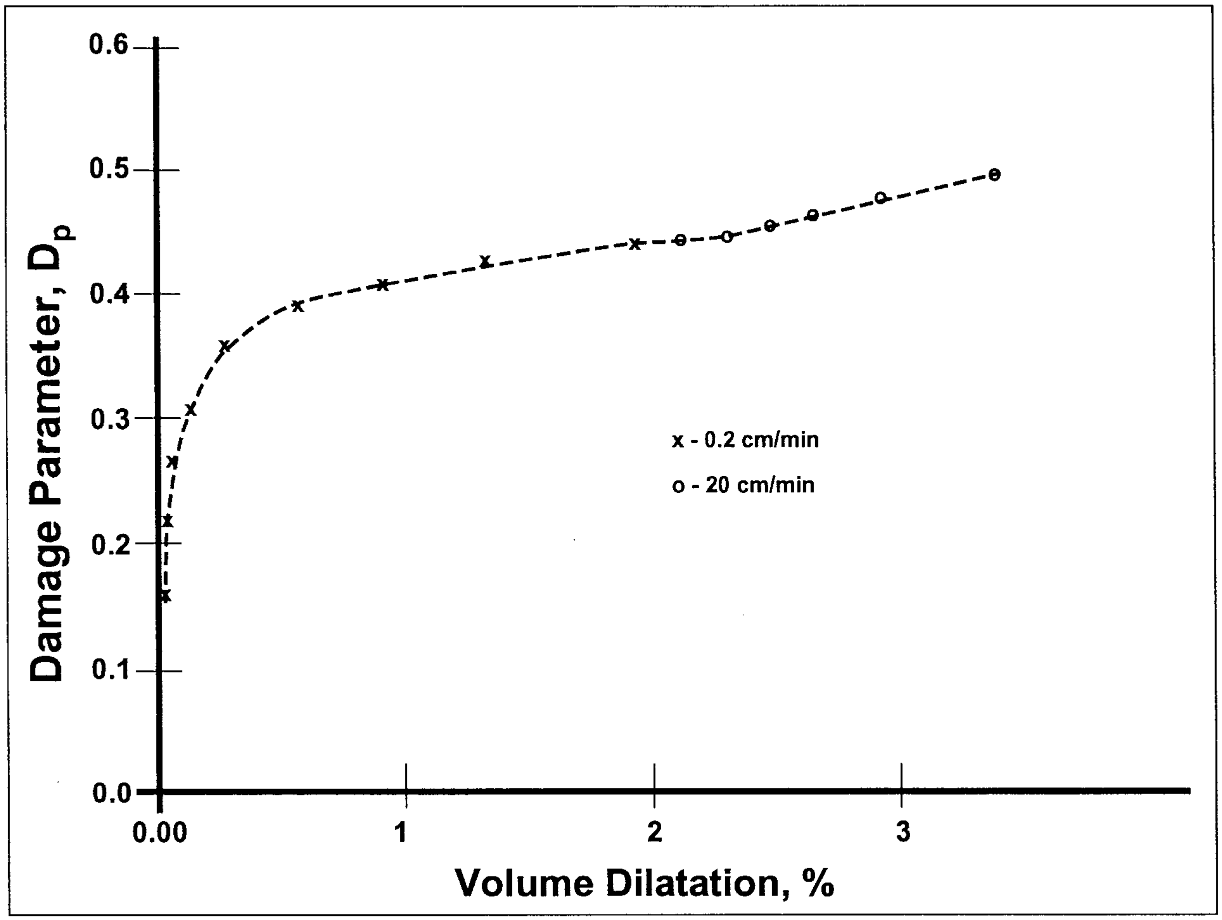
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.00
1
2
3
Damage Parameter, D_p
Volume Dilatation, %
x - 0.2 cm/min
o - 20 cm/min

Conclusions:

- For a given time, displacement rate has a significant effect on the damage intensity.
- The critical damage intensity is insensitive to the displacement rate and loading history.
- A good correlation exists between damage intensity and volume dilatation.
- The phenomenological damage parameter correlates well with the micromechanics damage parameter